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BEFORE THE BOARD OF OIL, GAS AND MINING
DEPARTMENT OF NATURAL RESOURCES
STATE OF UTAH

IN THE MATTER OF THE REQUEST FOR AGENCY ACTION OF LIVING RIVERS TO APPEAL THE DECISION BY THE DIVISION OF OIL, GAS AND MINING TO APPROVE THE APPLICATION OF EARTH ENERGY RESOURCES TO CONDUCT TAR SANDS MINING AND RECLAMATION OPERATIONS AT THE PR SPRINGS MINE	:	**NOTICE OF FILING OF TECHNICAL TESTIMONY OF CHARLES H. NORRIS** **Docket No. 2010-027** **Cause No. M/047/0090 A**

Living Rivers, by and through its attorneys, hereby files the prepared direct testimony of Charles H. Norris in the above matter.

Dated: January 7, 2011.

ROB DUBUC
JORO WALKER
Attorneys for Living Rivers

CERTIFICATE OF SERVICE

I hereby certify that on this 7th day of January, 2011, I served a true and correct copy of this prepared direct testimony of Charles H. Norris to each of the following persons via email:

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PREPARED DIRECT TESTIMONY

OF

CHARLES H. NORRIS

ON BEHALF OF

LIVING RIVERS

January 7, 2011

INTRODUCTION AND QUALIFICATIONS

Q. PLEASE STATE YOUR NAME?

A. My name is Charles H. Norris

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT POSITION?

A. I am a geologist with Geo-Hydro, Inc. (GHI), a Colorado corporation of which I am majority stockholder. My office is located at 1928 E 14th Avenue, Denver, CO 80206.

Q. WHAT IS YOUR EDUCATIONAL BACKGROUND?

A. I received a B.S. with Honors and with distinction in geology from the University of Illinois at Urbana-Champaign in 1969. I received an M.S. in geology from the University of Washington in Seattle. In 1970 I enrolled in a PhD program in geology at the University of Illinois at Urbana-Champaign with a concentration in hydrogeology, where I completed course work and passed the preliminary examination on thesis research. I did not finish or defend my dissertation. During my M.S. and PhD studies I was supported by a National Science Foundation graduate fellowship.

Q. BRIEFLY, WHAT IS YOUR EMPLOYMENT BACKGROUND?

A. The first 15 years of my professional career, from 1972 through 1986, were in the petroleum industry. I worked for several major corporations (Shell, Amoco International, Tenneco), a number of small and intermediate independent companies, and from 1982 to 1986 owned and operated Emerald Gas and Oil. Following that, I held a non-teaching faculty appointment 1987 to 1992 with the Laboratory for Supercomputing in Hydrogeology in the

Geology Department at the University of Illinois at Urbana-Champaign. I then concentrated on consulting in geology and hydrogeology, first as Director of Hydrogeology in Denver for what was then HydroSearch (now part of Geotrans) and, since 1994, as founder and owner of GHI.

Q. WHAT TYPE OF WORK DO YOU DO WITH GHI?

A. I provide consulting services in geology and hydrogeology. Through the years I have specialized in hydrogeology, with particular training and experience in geochemistry and modeling of both flow and water quality. My client mix has included local citizens' groups, regional and local environmental organizations, hard rock and coal mining companies, utility companies, other consulting companies, and municipal, state, and federal agencies. Technical projects have included permitting, review of permit applications, water resource development, expert testimony, and contamination delineation, forensics, and remediation.

Q. DO YOU HOLD ANY LICENSES OR REGISTRATIONS, AND, IF SO, WHERE?

A. I have been a licensed Professional Geologist in Utah since 2003. I am also licensed or registered as a Professional or Certified Geologist in Wyoming, Illinois, Indiana, Pennsylvania, Kentucky, Wisconsin, and Virginia.

Q. DO YOU HOLD MEMBERSHIPS IN ANY PROFESSIONAL ORGANIZATIONS?

A. I am a decades-long member of both the National Ground Water Association and the Colorado Ground Water Association (CGWA). I am currently a Board member of CGWA and in years past have served as Vice President and President.

Q. COULD YOU DESCRIBE GENERALLY YOUR EXPERIENCE IN PROVIDING EXPERT TESTIMONY?

A. I have testified before municipalities, counties, various State Boards, Colorado Water Court, a Federal administrative hearing, and Federal District Courts. In the spring of 2010, I testified at a deposition and hearing before the Utah Board of Oil, Gas and Mining (Board) in the Alton Mining appeal.

Q. FOR WHOM ARE YOU TESTIFYING IN THIS PROCEEDING?

A. I am testifying on behalf of Living Rivers.

II. PURPOSE AND SUMMARY OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of my testimony is to provide expert review and opinions pertinent to portions of the Board's consideration of the petition filed by Living Rivers appealing the approval by Division of Oil, Gas, and Mining (DOGM) of the Earth Energy Resources (EER) Notice of Intent to Commence Large Mining Operations, M0470090 (NOI).

Q. WOULD YOU PLEASE SUMMARIZE YOUR TESTIMONY?

A. The NOI submitted by EER should not have been approved. The NOI is not yet complete and accurate, despite repeated reviews by DOGM staff. Key elements of the approval result from acceptance by DOGM staff of unsubstantiated assertions by EER to State agencies. Elements of the approval result from acceptance by DOGM staff of assertions by EER that rely

upon outdated and/or irrelevant concepts, methodologies, or protocols now known to be irrelevant for the applications for which they are used in the NOI. Elements of the approval result from acceptance by DOGM staff of assertions by EER that are contradicted by the data proffered by EER in support of the NOI.

My testimony will focus on three areas where these deficiencies and insufficiencies are most evident. First, my testimony will address the process materials and methods for extracting the bitumen from the ore rock. Second, I will testify to the certainty that leachate will be generated in and from the waste rock – both processed ore rock and interburden/overburden waste rock (IBOB) – and that the leachate will migrate from the mine and impact ground and/or surface water as a result. Finally, I will testify that the NOI, and the data it incorporates, provides no information relevant to the characteristics of the leachate that will form and no information from which EER, DOGM, other Utah agencies, or the public can divine the composition of the leachate.

III. MATERIALS REVIEWED AND RELIED UPON

Q. UPON WHICH MATERIALS DO YOU RELY IN FORMULATING THE OPINIONS TO WHICH YOU TESTIFY?

A. Materials upon which I rely fall into four general categories. First, I rely on the application materials and decision documents from Utah agencies relating to the submission and approval of the NOI. All of these documents were provided to Living Rivers by DOGM. Second, there are materials from the general body of traditionally published technical and

scientific articles and research pertinent to the issues in this proceeding. Third, there are general, web-published materials to improve my understanding of the extraction process proposed for the intended mining. Fourth, there is the collective body of information and understanding that constitutes personal education and experience.

Q. WITH RESPECT TO THIS FIRST CATEGORY OF MATERIALS, WHAT AGENCY- AND NOI-RELATED MATERIALS DID YOU REVIEW AND RELY UPON TO FORMULATE THE OPINIONS TO WHICH YOU TESTIFY?

A. These materials include the following:

1. 20070824 Analyses Reports by American Western Analytical Laboratories (AWAL) to EER for samples from Asphalt Ridge, with related email traffic. (20070824 AWAL to EER). *20070824* is the year, month and day of the document
2. 2008103 EER NOI, edited for public review, with large portions of data and discussion withheld as confidential. Neither EER nor DOGM would release any "confidential" information to Living Rivers. As a result, I was not able to review any of the confidential information that was allegedly included in or cited by the NOI.
3. DOGM approval of EER NOI
4. 20080222 EER "PR Spring Operation ...Permit-by-Rule Demonstration" (PBR Demo), text.
5. 20080324 DWQ Permit-by-Rule determination (DWQ PBR)
6. 20110103 EER Response to 1st request for production (EER 1st Resp)
7. 20110104 email from Machlis to Dubuc (20110104 email)

Q. WITH RESPECT TO THE SECOND CATEGORY OF MATERIALS, WHAT PUBLISHED TECHNICAL AND SCIENTIFIC MATERIALS DID YOU REVIEW AND RELY UPON TO FORMULATE THE OPINIONS TO WHICH YOU TESTIFY?

A. These materials include the following:

1. 20061212 Helms and Thorneloe, *Developments in Leach Testing*
2. 20030618 Dzombak, Science Advisory Board of USEPA, *TCLP Consultation Summary*
3. 20080700 Sanchez, Kosson, et al., *Characterization of CCR ...*, EPA/600/R-08-77
4. 20091200 Kosson, Sanchez, et al., *Characterization of CCR ...*, EPA/600/R-09-151
5. 20030512 Helms, *Background Discussion for SAB Consultation on Leach Testing*
6. 2003/06/03 Al-Abed, *Summary of ORD Research Plan on the Leaching of Metals from ...*, EPA Office of Research and Development
7. Al-Abed, *Roadmap for Current and Long-Term Research on Waste Leaching*, USEPA Office of Research and Development
8. 20091009 Thorneloe, Kosson, et al., *Improved Leaching Test Methods ...*, Proceedings.
9. 20020000 Kosson, van der Sloot, et al., *An Integrated Framework for Evaluating Leaching in Waste ...*, EPA-HQ-RCRA-2009-0640-0060
10. 20030617 Thorneloe, *Application of Leaching Protocol to ...*, US EPA Office of Research and Development

Q. WITH RESPECT TO THE THIRD CATEGORY OF MATERIALS, WHAT GENERAL, WEB-PUBLISHED MATERIALS DID YOU REVIEW AND RELY UPON TO FORMULATE THE OPINIONS TO WHICH YOU TESTIFY?

A. These materials include the following:

1. http://www.earthenergyresources.com/technology.htm
2. http://www.earthenergyresources.com/faq.htm
3. http://www.earthenergyresources.com/current_news_28.htm
4. http://www.allbusiness.com/business-planning-structures/starting-a-business/1132222-1.html
5. http://repository.icse.utah.edu/dspace/bitstream/123456789/5230/1/Snarr_OilSands_09.pdf
6. http://www.canadianminingjournal.com/issues/story.aspx?aid=1000386577
7. http://www2.macleans.ca/2010/06/24/another-alberta-apocalypse/
8. http://www.globe-net.com/articles/2010/september/15/canadian-energy-start-up-at-centre-of-us-oil-sands-fight.aspx?sub=15
9. http://www.peteducation.com/article.cfm?c=2&aid=2281
10. http://en.wikipedia.org/wiki/Limonene#Safety

Q. WITH RESPECT TO THE FOURTH CATEGORY OF MATERIALS, WHAT ASPECTS OF YOUR EXPERIENCE AND EDUCATION DID YOU PARTICULARLY RELY UPON TO FORMULATE THE OPINIONS TO WHICH YOU TESTIFY?

A. Most relevant to my evaluation of EER's proposed mining and waste disposal are my years of experience working with and on waste characterization, geochemical modeling, mine permitting and remediation, site characterization, and water resources in the arid west. In addition, I relied upon the following treatises: Groundwater by Freeze and Cherry, Aqueous Environmental Geochemistry by Langmuir, and Geochemical Reaction Modeling by Bethke.

IV. THE BITUMEN EXTRACTION PROCESS

Q. DO THE DOCUMENTS YOU HAVE REVIEWED PROVIDE A CLEAR AND DISTINCT UNDERSTANDING OF THE MATERIALS AND PROCESS(ES) THAT WILL BE USED TO EXTRACT THE BITUMEN FROM THE ORE ROCK AT THE PROPOSED MINE-MOUTH PROCESSING TRAIN?

A. Unfortunately, they do not.

Q. COULD YOU EXPLAIN WHAT YOU MEAN?

A. The materials that I reviewed pertinent to the extraction process include the NOI, the PBR Demo, and the above-cited web-published documents and articles about the Ophus Process, EER's commercial and public term for the extraction process. Collectively, these documents appear to provide a fairly clear and consistent picture of the process(es) used to extract the bitumen from the ore rock.

Particular to the process to be used at the EER site, there is no information that identifies the chemical(s) that is (are) to be used is (are), and the vocabulary used to describe the chemical(s) is inconsistent from one publically available source to another and even within some sources. An understanding or prediction of the impact to human health and the environment by the chemical(s) used to extract the bitumen is difficult when the specific chemical(s) are not identified and such basic characterization of the chemical(s) as Material Safety Data Sheet(s) (MSDS) is withheld. It also appears that the chemical(s) to be used, if not details of the process(es), are a moving target and have changed over time.

Q. WHAT ARE SOME OF THE TERMS USED TO DESCRIBE THE CHEMICAL(S) USED FOR EXTRACTING THE BITUMEN?

A. Within the NOI, there is appears to be a distinction between an extracting chemical and an emulsion that is used for the actual extraction. An emulsion is an intimate blend of two liquids that remain maintain separate phases, but can move and flow as a single fluid. Vinaigrette is an example of an emulsion. The extracting chemical is alternatively described as a *solvent*, a *cleaning chemical*, and a *process chemical*. The extracting chemical is characterized as stable, colorless, volatile, negligibly soluble in water, combustible and explosive. This extracting chemical is required to be blended with unknown, uncharacterized additives to form a *cleaning emulsion* or the *cleaning emulsion form*. The emulsion is characterized as non-explosive and of low flammability. It is also acknowledged that the emulsion has not been established to be biodegradable.

Within the PBR Demo, the descriptive language is similar to that in the NOI. It describes a *cleaning emulsion* that is insoluble in water, that rapidly evaporates and that may not be biodegradable. An MSDS for the emulsion purportedly was provided to Division of Water Quality (DWQ) but has not been provided to the public. In addition to cleaning emulsion, descriptive terms include *cleaning chemical*, *cleaning agent*, and flammable *process chemical.*

The representation of the extracting agent to the general public through the EER website and industry news outlets is substantially more varied. Language includes *proprietary catalyst*, Ophus *catalyst*, *catalyst*, *environmentally friendly extraction chemical*, *biodegradable solvent*,

proprietary solvent, *agricultural by-product*, *biodegradable and environmentally friendly chemical*, and *citrus-based solvent*.

Q. WHAT IS THE SIGNIFICANCE OF BLENDING ADDITIONAL CHEMICALS TO FORM A CLEANING EMULSION?

A. The NOI and the PBR Demo describe bonding between the extraction chemical and the bitumen during extraction. Separation of the extracted bitumen from the process stream simultaneously removes the bound extracting chemical from the process stream. The removal of the extracting chemical from the process water as bitumen is extracted correspondingly reduces its concentration in post-extraction water. The NOI and the PBR Demo do not describe the fate of the chemical additives. Presumably the additives remain in the post-extraction water at their full concentrations.

Much of the post-extraction water is recycled for reuse. However, a significant portion, around 116 gallons per minute (gpm), is entrained within the spent ore rock and disposed of in the mine. While the extraction chemical will be partially depleted within the disposed water, the disposed water will still contain the full strength of the emulsion-creating additive(s). The impacts of these additives to water, the environment, livestock, or even human health cannot be quantified until the compositions, concentrations and characteristics of the emulsion-creating chemical(s) are released.

Q. WHAT DID YOU MEAN WHEN YOU INDICATED THE EXTRACTION PROCESS WAS A MOVING TARGET?

A. EER apparently no longer will use the extraction process that is described in the NOI and PBR Demo. In its response to discovery production requests (EER 1st Resp), EER asserted that the use of an emulsion is now "unnecessary and will not be used as part of the Ophus process." As described in the NOI, the emulsion was "required" and at least served the purpose of converting the extraction chemical from a liquid that was highly volatile, flammable, and explosive into a fluid that was much less volatile and non-explosive. If one assumes EER did know the characteristics of the extraction chemical at the time the NOI was written, either EER is now willing to accept previously unacceptable work place risks, or the process is using a different extraction chemical, one with different chemical and physical properties.

In a follow-up reply to Living Rivers' request for clarification of EER's discovery response (20110104 email), EER stated, "Earth Energy does intend to use the terpene component in the Ophus process, but Earth Energy no longer intends to use a separate stabilizer in the Ophus process." It is unclear what "the terpene component" is and its relationship to the original extracting chemical. If it is the same compound, then EER apparently is for some reason more comfortable with its dangers.

Q. DOES THE TERM "TERPENE COMPONENT" PROVIDE ANY INSIGHT INTO THE NATURE OF THE ACTIVE CHEMICAL IN THE EXTRACTION PROCESS?

A. The use of the term "terpene" narrows somewhat the range of speculation regarding the "magic ingredient" used in the Ophus Process, but it still leaves a wide range. Terpenes are hydrocarbon chains that can be biologically produced by a variety of plants. They serve as structural components in a wide variety of complex molecules. Among organic chemicals

containing terpene(s) are fragrant light organic oils produced by fruits, including citrus fruits. Thus, the oblique references from the EER website and quotes in industrial press to an *agricultural by-product*, and to the *citrus-based solvent* are consistent with *the terpene component*. Much of the language used to describe the active extraction chemical is consistent if the chemical now being used in the Ophus Process is a form or mix of oils from citrus peals.

Q. WHAT MIGHT BE THE GENERAL CHARACTERISTICS OF THE EXTRATION CHEMICAL IF IT IS A FORMULATION OF CITRUS OILS?

A. The chemical characteristics of each citrus oil will vary some from other citrus oils. Generally, citrus oils are highly flammable, highly volatile, and explosive. They are also quite fragrant. One commonly used citrus oil extract (from orange peel) is D-limonene (CAS number 5989-27-5). It is used as industrial solvent, as household cleaning fluid, and in cosmetics. It is also used as an insecticide. Citrus oil extracts (limonene and linlool) are lethally toxic to household pets, to cats more so than dogs. If the Ophus Process active ingredient is citrus oil, or a derivative thereof, it should be taken seriously as both as a work place and toxicity risk. The NOI is mute on both issues.

V. POTENTIAL FOR LEACHATE GENERATION

Q. WHERE WILL PROCESSED ORE ROCK BE DISPOSED AT THE MINE?

A. It will initially be co-disposed with IBOB outside the mine pit. Once the mine excavation is sufficiently large, the processed or rock will be disposed within the pit.

Q. WHAT IS THE REPRESENTATION BY EER OF THE WATER CONTENT IN THE PROCESSED ORE ROCK?

A. Within the NOI and the PRP Demo, EER provides various numeric estimates of the water content of the processed ore rock as percent water. The range of water content is generally within the range of 10 to 20 percent.

The most commonly used qualitative phrase is that the processed ore rock will be *damp* or *damp-dry*. The perception of low water content in the disposed processed ore rock is further developed in the web-published commentary as well, using the terms *dry tailings*, *damp-dry*, *no wet tailings*, and *damp*.

Q. WHAT ARE THE IMPLICATIONS OF THE EER REPRESENTATIONS OF WATER CONTENT WITH RESPECT TO LEACHATE GENERATION?

A. The numeric quantification of the water content in the processed ore rock is inconsistent with the qualitative verbal description. The numeric characterization describes high water content and the verbal characterization describes low water content.

If the processed ore rock contains substantial water at the time of disposal, that water can migrate to the bottom of the disposed mass and leachate generation begins immediately. The higher the water content in the disposed waste, the higher the volume of immediate leachate generation and the sooner migration will occur from the disposal area. If the processed ore rock contains little water, leachate formation and migration from the disposal area will develop only after sufficient non-process water enters the disposal area allow migration.

Q. LET'S EXAMINE EACH OF THOSE CHARACTERIZATIONS. IS THE "DAMP-DRY" CHARACTERIZATION OF THE PROCESSED ACCURATE?

A. No, absolutely not.

Q. WHY NOT?

A. The quantitative data in the NOI and the PBR DEMO do not characterize a dry or even relatively dry waste. The data, in fact, document porous, unconsolidated sediment that is virtually saturated completely with water.

Consider the data presented in both the NOI and the PBR Demo. A daily run of 2000 barrels of extracted bitumen processes 3000 to 3500 tons per day of ore rock (NOI, p. 16). The bitumen recovered from the ore rock constitutes 10-12% by weight of the ore rock (NOI p.14). If the average, 11%, is used to characterize the bitumen recovery, processing 3000 to 3500 tons per day produces 2670 to 3115 tons per day of spent ore for disposal.

Water consumption (entrained moisture with the processed ore being disposed in the mine) for a production run of 2000 bbl/d of product is 116 gpm (NOI, p. 17), or 167,040 gallons per day (gpd). This is equivalent to 668 tons/day of water being disposed in the mine. Combining the water and processed ore waste streams, the daily total disposal is between 3338 and 4663 tons, of which water is 668 tons. These daily-run estimates generate a mass-based water content in the processed ore rock of between 20% and 14%, verifying both the numeric values reported in the NOI and verifying that the reported values in the NOI are mass-based water content values.

Water movement through sediments is a function of the portion of pore spaces occupied by water. It is not a function of the relative masses of rock and water. To appreciate how wet this waste stream is, the mass-based water content must be converted to volume-based water content. Based upon mass ratios, there is between 4.0-fold and 4.7-fold as much rock as there is water; i.e., water is a significant but minor mass component of the waste. But, the rock fraction is characterized as predominantly quartz, which has a specific gravity of 2.65. Water has a specific gravity of 1. Converting the mass ratios to volume ratios, there is only between 1.5-fold and 1.8-fold as much rock volume as there is water volume.

These volume ratios between sand and water document water-filled porosity of a very unconconsolided sand (35% + porosity). They do not represent damp-dry sediments, and they become damp-dry to touch only because water does free-drain away from the surface almost immediately, like a wave into beach sand. One can readily build a sand castle at a real beach, forming damp-dry sand into turrets minutes after water from the last wave has ebbed away. No one would reasonably postulate the beach sediment as anything other than the upper surface of a free-draining system.

Q. IS THERE ANY EVIDENCE IN THE RECORD THAT DEMONSTATES THAT THE PROCESSED ORE ROCK DATA SHOW HIGH SATURATIONS AND FREE-DRAINING POTENTIAL FOR THE WATER ENTRAINED WITH THE PROCESSED ORE ROCK, AND IF SO, WHERE?

A. Yes, there is. In August 2007, EER sent ore and processed ore samples to AWAL of a variety of analyses (20070824 AWAL to EER). On the day of shipping, August 8, 2007, Barclay Cuthbert (EER) emailed Lynn Turner (AWAL) describing the shipment. That email said in part, "The processed sand and processed fines samples contain significant percentages of water (up to 22%) and some separation of the water from the sand matrix typically occurs after the sand or fines samples have sat for a period of time."

Q. WHAT IS THE SIGNIFICANCE OF THE PLACEMENT OF FULLY SATURATED SEDIMENTS IN THE DISPOSAL AREAS OF THE MINE?

A. It means there is a high volume of mobile water being transported into the waste disposal areas along with the solid waste. Not only is the water immediately available to react with the solid wastes forming leachate, there is no waiting time of years or decades to reach a mobile saturation. The initial mobile water is introduced with the spent ore rock in sufficient volume to be immediately mobile and migrate as leachate, whether downward through the bottom of the mine pit or laterally over the lip, depending on the pit configuration.

Q. WHAT IS THE EER REPRESENTATION OF WHERE OR HOW LEACHATE WILL MIGRATE FROM THE SITE?

A. The EER representation of migration from the intended mine is that it will not migrate from the site. The EER representation assumes that little or no entrained water will be placed in the mine and much of what is placed there will evaporate during or immediately following placement. EER represents that precipitation in the area of the mine is so limited that the water will virtually all be lost to evaporation, uptake by reestablished vegetation after reclamation or

run-off as surface discharge after reclamation. EER further represents that were some amount of water were to infiltrate, it would be trapped within the confines of the pit due to the design of the pit so that the bottom of the pit is always below the rim. Finally, EER represents that the low permeability of the native strata under the mine would preclude downward migration as groundwater.

Q. IS THAT REPRESENTATION ACCURATE OR POSSIBLE, AND IF NOT, WOULD YOU PLEASE EXPLAIN?

A. No, the representation is neither accurate nor possible. The issue would not be whether leachate would leak and migrate, only when. Even the proverbial *de minimus* infiltration rate will produce sufficient saturation to migrate given sufficient time. That water will migrate from the bottom of the pit if there is sufficient head and permeability. If water cannot move through the floor of the pit, eventually water levels within the closed pit will reach a low point on the rim of the excavation and lateral migration from the pooled leachate will begin.

However, hypothetical consideration of the EER representation is unnecessary, because its assumptions are clearly inappropriate. As described earlier in my testimony, the disposed waste is so waterlogged that the pit of the mine will be filled with water (leachate) virtually as fast as the pit is filled with processed ore rock. Migration through the bottom or sides of the pit can start virtually immediate. If process water is introduced faster than it can infiltrate through the bottom and sides, water levels within the pit will rise high enough to migrate over the lip. Before this, however, water-bearing processed ore is being disposed outside of the pit. Water draining from this processed ore need not collect to any height to migrate away from the disposal

area.

Q. ARE THERE DATA TO SUGGEST THAT INFILTRATION OF WATER FROM THE BASE OF THE MINE THROUGH NATIVE STRATA IS POSSIBLE AND WOULD YOU PLEASE EXPLAIN YOUR ANSWER?

A. Yes, there are such data. Evidence of the opportunity for water to migrate through the native strata is found in both the NOI and the PRP DEMO. Both documents describe springs and seeps in the vicinity of the intended mining and the hydrologic conditions under which they occur. The springs demonstrate shallow hydrologic flow systems that can only exist if there are pathways for precipitation that fall in the area to migrate into the native strata and laterally to discharge where seeps and springs are located. The characterization of the intended mining area is deficient in that little if any effort was made to establish site-specific shallow characteristics. But, the data from the general area proposed for mining leaves no doubt that there are pathways at the surface for migration into and through the native strata.

Q. IS THERE EVIDENCE THAT INFILTRATION DOWNWARD THROUGH NATIVE STRATA IS PROBABLE AND WOULD YOU PLEASE EXPLAIN?

A. Yes, I believe there is. The NOI and the PRP DEMO both describe the intent to line holding ponds with synthetic (HDPE) liners, for the express purpose of preventing water loss due to infiltration into the native strata beneath the ponds. The documents are explicit that the liners are not for water quality or pollution control, only for infiltration control. The use of synthetic liners for ponds is not cheap; the cost would not be incurred unless there were a real perceived need that such infiltration would likely occur. It is a reasonable presumption that this

expense is budgeted because of EER's full expectation is that without synthetic liners, ponds at this mine would not hold water.

Q. WILL LEACHATE BE GENERATED AT THE SITE, AND, IF SO, WHEN?

A. Yes leachate at this mine. It will be generated on the first day that processed ore rock with entrained process water is placed on the site, and every day thereafter.

Q. WHAT WILL BE THE FATE OF ANY LEACHATE THAT IS GENERATED AT THE SITE?

A. The leachate will migrate away from the intended mine as soon as it finds an available pathway and there is a hydraulic gradient to move it through that pathway. Since free-draining water will exist in the processed ore rock at the time of disposal, vertical migration downward will begin immediately. Lateral migration will occur as soon as a lateral migration path is available. Because the processed ore rock is so fully saturated, lateral migration from the intend mine can be expected soon after waste levels within the pit find a pathway either into underlying or adjacent strata or reaches the elevation of the lip of the pit.

Q. CAN THE LOCATION, TIMING, AND RELATIVE MAGNITUDE OF ANY LEACHATE MIGRATION FROM THE SITE BE PREDICTED?

A. Unfortunately, due to the lack of site-specific characterization of hydrogeology and mine configuration, specifics cannot be provided with respect to identifiable paths of migration, projected times of migration, or the relative importance of vertical to lateral migration. Without the site-specific characterization, there cannot be and there is no monitoring program that will

timely confirm the migration. So, even though leachate migration begins immediately, EER, DOGM, the public, and the environment will have to wait until any problems are evident, when and where they become evident.

VI. CHARACTERIZATION OF LEACHATES FROM WASTE MATERIALS

Q. HAVE YOU REVIEWED THE LEACHING TEST DATA PROCURED BY EER AS PART OF IT'S PREPARATION OF THE NOI AND THE PBR DEMO?

A. Yes, I have. I have reviewed the 2005 analytical data from PR Spring as it is presented in the PBR DEMO. I have reviewed the 2007 analytical data as it is presented in the PBR DEMO and reviewed it in the analyses reports from AWAL to EER for the Asphalt Ridge samples (20070824 AWAL to EER). Included with the latter analyses were email communications related to the samples and the analyses.

Q. PLEASE SUMMARIZE YOUR ANALYSIS OF THIS ANALYTICAL DATA?

A. The tests that EER had run for waste and leachate characterization in 2005 and 2007 are remarkable primarily in the number and variety of ways that they were improperly conducted.

Q. IN WHAT WAY WERE THESE TESTS IMPROPERLY CONDUCTED?

A. Properly conducting these requires that the analyses be performed prior to the expiration of applicable holding times. It requires that the laboratory analyses be performed correctly and reported at concentration levels that are of interest. As described in the PBR DEMO (pp. 8-12), these procedures were not generally followed.

As a result of the failure to follow appropriate procedures in both the 2005 and 2007 sampling programs, few defensible data were produced. Volatile and semi-volatile organic analyses were compromised by air space in sampling jars, exceeding holding times getting the samples to the laboratory, or exceeding holding times at the laboratory. Some metal analyses could not be compared against a desired standard because the reporting limits for the tests exceeded the standard of comparison. An analysis for Total Dissolved Solids (TDS) specifically requested by DWQ could not be used because the test was run using inappropriate methods. With respect to TDS, EER acknowledges, "The expected TDS of leachate that might develop from the processed oil sands is not known, …" Although TDS is a major consideration in a determination of permit-by-rule, EER did submit its demonstration without it.

Q. WHAT DO THESE ANALYSES CONVEY ABOUT THE LEACHATE THAT WILL FORM AT THE PROPOSED MINE?

A. Nothing. Nor could they have. Even had the sampling, sample preservation, holding times, analytical methods, reporting units and detection limits been performed properly, these analyses would convey nothing about the leachate that will form in the disposed wastes at the intended mine. These tests were not designed to simulate field leachate concentrations, are not capable of simulating field leachates and are not appropriately used for that purpose.

Q. IS THE TCLP THE TEST DESIGNATED BY USEPA FOR DETERMINING LEACHATE COMPOSITION?

A. No, it is not. It is the specified test protocol to determine whether a waste is "hazardous

by characteristic" for a limited list of constituents with respect to management of that waste under the rubric of Subtitle C or Subtitle D of RCRA. It was developed for that purpose and it is useful for that purpose.

Through the years, a myriad of other uses for the TCLP, and for derivatives of the TCLP such as the SPLP or the ASTM shake test. Although uses of the TCLP and its derivatives can be defensible for indexing and screening purposes analogous to that of the hazardous waste screening, these tests cannot appropriately be used for estimating leachate that will form in wastes disposed in the environment. The tests simply are incapable of doing that.

Q. IS IT GENERALLY RECOGNIZED THAT THE TCLP/SPLP TESTS CANNOT PREDICT LEACHATES THAT FORM IN THE FIELD?

A. It is becoming generally recognized that TCLP/SPLP tests cannot predict leachates that form in the field, and certainly at the federal level the limitations of these tests in that respect have been recognized. For years, mining regulators have known that a test like the TCLP cannot assess leachates that will develop in spoil or tailing wastes that contain reactive minerals, for example. Certainly, a coal mining application that proposed to use the TCLP or SPLP as a predictor of the potential acid mine drainage would be summarily rejected.

The limitations of the TCLP and derivative tests have been known and described by the Science Advisory Board of the U.S. EPA since the early 1990s. In part due to the increasing concern over placement practices for coal combustion waste (CCW), the dissemination of data about and appreciation of the limits have increased. EER's lab is clearly aware of limitations of

the SPLP test. In the 20070723 email from Pat Noteboom (AWAL) to Barclay Cuthbert (EER), AWAL made it clear that, "SPLP alone is ambiguous. It is a leaching procedure which must be followed up [with] an analysis."

In Section III of my testimony, I have provided a number of published technical and scientific references that address the limitations as they are understood today.

Q. HAS THE U.S. EPA ESTABLISHED A TEST PROTOCOL FOR PREDICTING FIELD LEACHATE COMPOSITIONS THAT WILL FORM AT DISPOSAL SITES?

A. It has not yet done so. It provides a guideline in the risk assessment of CCW disposal facilities at power plants with respect to which types of data are most reliable with respect to estimating leachate compositions. The data source deemed most reliable is the sampling of field leachate from an existing disposals location of the waste itself, if such a disposal site exists. The data deemed least reliable are TCLP/SPLP analyses. The current approach emphasizes the use of leaching tests with high solid to liquid ratios and/or long duration tests because such conditions are likelier to allow equilibrium reactions to develop, as they do in the field.

Q. HOW CAN ONE REACH SOME UNDERSTANDING OF LEACHATES THAT MAY FORM IN THE FIELD AT A FACILITY LIKE THAT AT THE PROPOSED MINE?

A. An evaluation of six steps can produce in-depth understanding of the leachate that is likely to form. The first step is an elemental bulk analysis of the waste materials involved. For the proposed mine, this would include the processed sand and fines of ore rock and the IBOB. The second step is a mineralogical analysis of the waste materials to determine the phase

distribution of elemental composition. For example, it is important to understand whether sulfur is found in organic sulfates or in metal sulfides to project weathering impacts. The third step is to analyze fully the process water that will be initially entrained in the waste. The fourth step is a leaching test attempting to simulate site-specific conditions to assess initial leachate composition. A multi-pass, column leaching test might be appropriate. The fifth step would be an analysis of any receiving waters for migrating leachate. The final step would be computer simulations of the effects of time dependent changes in the waste, such as those resulting from oxidation and weathering of the waste.

Q. ISN'T THE ASSESSMENT SEQUENCE YOU DESCRIBE FAR BEYOND ANYTHING DONE TODAY TO FOR SIMILAR ACTIVITIES, AND FAR TOO EXPENSIVE?

A. Properly designed and run, this leachate characterization would not be substantially more expensive that what was done for this operation, which produced little or no usable data of any kind and no understanding of expected leachate composition. The proposal would have the benefit of producing information that could be used and relied upon to demonstrate short-term and long-term environmental protection and regulatory compliance. The proposal includes efforts that are typically undertaken as part of waste management design plans at, for example, hard rock mines with sulfide-bearing ores.

Q. WHAT TYPES AND LEVELS OF CONTAMINATION CAN ONE EXPECT AT THE PROPOSED MINE DUE TO THE EXTRACTION CHEMICALS?

A. Presently the information about the composition(s) or concentrations of the extraction chemical and/or any additives that may be blended is being withheld. Quantified integrated of

the impacts of the extraction chemicals into my assessment awaits the release of that information.

Q. ARE THERE SOURCES OF CONTAMINATION OTHER THAN THE PROCESSED ORE ROCK THAT MAY IMPACT LEACHATE QUALITY?

A. Yes. First, more processed ore that is being disposed. The IBOB strata are being disturbed, transported and disposed. There are no data or assessment at this point of these rocks and their potential to generate toxic drainage. Second, the process water is imported water to the site. The source of the water is an aquifer in a different formation and from a substantially greater depth. The description of this water provided in the NOI indicates that it can be expected to have substantially greater TDS than local shallow water. The use of this water in the extraction process creates a new source of relatively contaminated water to already impaired drainages through its disposal in the mine as part of the spent ore rock disposal.

Q. IS IT LEGITIMATE TO FOREGO CONCERNS ABOUT LEACHATE COMPOSITION BECAUSE THIS AREA IS REMOTE FROM PERENNIAL STREAM FLOW?

A. No, it is not. Distance will not protect perennial reaches of a drainage from contamination in intermittent and ephemeral stream. First, subsurface alluvial flow can exist in a stream system when no surface flow is evident. So, a lack of visible flow is not evidence that contaminant transport is not occurring. Second, and more significantly, periods of no flow in intermittent and/or ephemeral streams are simply holding periods for dissolved constituents; migration is interrupted, not stopped. The contaminants will remobilize with the passage of new water and continue their journey to the reaches of perennial flow. To the extent that the intended

mining will introduce a new water source of 116 gpm into the mined area, more persistent flow may well develop. This imported water is expected to have a higher TDS than other shallow discharges in the vicinity of the mine, and the result will increase the load of at least TDS to the stream.

VII. CONCLUSIONS

Q. WHAT DO YOU CONCLUDE?

A. Based upon my review of the materials listed above, my experience, and my education, I reach the following four conclusions:

First, the degree, magnitude, and level of contamination in the entrained process water disposed in the mine cannot be quantified until the information on the extraction chemicals that have been provided and released by EER for public review. Further, based upon the EER response to production requests, it appears the Ophus Process has been materially changed from that presented by EER to DOGM and DWQ.

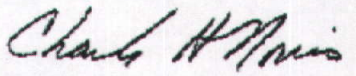
Second, the NOI and the Permit-by-Rule Demonstration are fatally flawed because they rely on inappropriate and misleading pairing of data developed by EER quantifying the processed ore rock being disposed as fully saturated with water, to the point the water is free-draining, with a false descriptive characterization of the processed ore rock as damp-dry and dry. The waste stream is waterlogged and leachate will pool in and saturate the waste, rising as waste levels rise. These conditions must be unambiguously stated and assessed before the NOI can be accepted and the appropriateness of a permit by rule determined.

Third, there are no valid water quality data from which to project the quality of the initial leachate that will form in the mine and there is no effort to determine how the leachate quality will evolve as time progresses. There is no attempt by EER to develop meaningful estimates of leachate composition.

Fourth, there will be a lot of leachate, generated at rate of at least 116 gpm, if only considering water imported by the on-site extraction process. That is more leachate than the documented discharge of groundwater from all of the local springs. The quality of the leachate will be substantially worse than the local shallow groundwater discharged from seeps and springs in the area, if only considering the water quality of the water source for the extraction process. The mine pit will not hold and contain the leachate. Regardless of whether it migrates from the pit laterally, vertically, or both, there will be migration of leachate of undetermined water quality from the mine. There will be impacts to surrounding water resources. Neither the NOI nor the PBR demonstration acknowledge these conditions and until they do, they should each be denied.

Q. DOES THIS CONCLUDE YOUR TESTIMONY FOR NOW?

A. Yes.



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